

METALLIC SPHERULES IN THE IMPACT GLASS EJECTA FROM THE METEOR CRATER, ARIZONA, AND THEIR ORIGIN SIMULATED EXPERIMENTALLY.

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The glass fragments are found in the impact ejecta from the Meteor Crater as aerodynamically shaped, centimeter-sized masses of vesicular glass that contain micron-sized spherules of Ni-rich metal [1,2]. They are dominated by silica glass, but also contain unmelted quartz grains with planar cleavage and some devolatilized carbonate. Similar Ni-Fe spherules are known from the impact glass bombs in Wabar [3,4].

The origin of metallic spherules in the impact glass was simulated experimentally. The fine pulverized Coconino sandstone and filings of the Fe-meteorite Canon Diablo and Sikhote-Alin were mixed together in the proportion of 99.9 % to 0.1 % and 99.5 % to 0.5 % respectively. The mixtures were inserted and pressed in the holes of the carbon electrodes covered with pure carbon dust not to splutter and put into the electric arch (Zeiss spectrograph PGS 2, $t = 2\,780 \pm 100$ °C). At 12 s a thin glassy crust has appeared on the surface in both cases. At 69 s of exposition, the glass spherules of silicate glass have appeared and inside there originated the metallic spherules of about 6 - 10 μm in diameter with higher Ni content ($x = 14.88 - 15.94$ wt % Ni, s.d. = 1.01, $n = 16$; in one point analysis we have found 22.54 wt % Ni, but the metallic spherule has been partly covered by silicate glass layer because in the analysis there was found 7.5 wt % Si; analyzed in the electron microanalyzer Camebax). Other elements found in traces are not discussed now. At 88.5 s, all material

was almost completely vaporized. Because the fine filings of iron meteorites used in experiment, practically the only one source of Ni in the process, have only 6.97 (Canon Diablo) and 5.88 wt % Ni (Sikhote-Alin), it was evident that the spherules in the prepared glasses are enriched by Ni.

The iron content slightly arises in the glass surrounding the spherules. All the material was melted during the experiment and then during the relatively rapid cooling the metallic blebs with higher Ni-content of a sphere or oval shape segregated from the silicate superheated melt as immiscible component. Even when the results are not quantitatively the same as in the impact glass, the test proved that the origin of the metallic spherules passed in similar way also in natural conditions of the impact.

The distribution of iron and nickel between metallic and silicate phases was estimated on the basis of equilibrium calculations. A general method [5] based on minimization of the total Gibbs energy of the system on a set of points satisfying the material balance conditions was used to calculate the equilibrium composition. Fifteen gaseous species, two immiscible liquid phases (metallic and silicate) and solid graphite were included in the calculation. The metallic liquid was described as the ternary solution of Fe, Ni and Si using the Redlich-Kister equation for the excess Gibbs energy term. Model of an ideal solution of complex oxides was used to describe the silicate melt. FeO , NiO , SiO_2 , CaO , MgO , Fe_2SiO_4 , Ni_2SiO_4 ,

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CaSiO_3 , Ca_2SiO_4 , MgSiO_3 , and Mg_2SiO_4 were chosen as components of this liquid phase.

The calculations were carried out at atmospheric pressure in the temperature range of 2500 - 3000 K for various initial amounts of meteoritic alloy and Coconino sandstone. Calculated results (9.8 to 14.9 wt % Ni in metallic phase) show that the Ni/Fe ratio in metallic alloy increases during the interaction with sandstone at high temperature. This is due to higher affinity of

iron to oxygen in comparison with nickel. Consequently iron easier dissolves in the silicate melts where it is present as divalent iron oxide.

References: [1] Brett R.(1967) *Am. Mineral.*, 52,721 - 733. [2] Kargel J.S. et al. (1995) *1995 Fall Meeting*.Abstract volume. [3] Larson R.R. et al. (1964) *Ann. N.Y. Acad. Sci.*,119, 282 - 286. [4] Spencer L.J. (1933) *Mineral. Mag.*, 23, 387 - 404. [5] Vonka P. and Leitner J.(1995) *CALPHAD Calculation of Phase Diagrams*, 19, 25 - 36.